



**Protocol for the Mixing Tower Test Program**

**To be Conducted at the Atlas Resin Proppants Facility  
Located in Taylor, Wisconsin**

*Protocol No. 4365  
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## Project Overview

### General

Airtech Environmental Services, Inc. (Airtech) has been contracted by Atlas Resin Proppants, LLC (Atlas) to perform an air emissions test program at the Atlas facility (Facility ID No. 627005280) located in Taylor, Wisconsin. The specific objectives of the test program are as follows:

- Determine the Destruction Efficiency (DE) of two (2) Recuperative Thermal Oxidizers (RTOs) installed to treat the solvent laden air (SLA) generated by the manufacture of resin-coated industrial sand.
- Determine the Capture Efficiency (CE) of two (2) bulk material mixing towers.
- Determine the emission rates of filterable particulate matter (PM), condensable particulate matter (CPM) and total PM from each RTO exhaust
- Determine the emission rate of oxides of nitrogen (NO<sub>x</sub>) from the exhaust of each RTO
- Determine the emission rates of phenol and formaldehyde from the exhaust of each RTO
- Determine the emission rate of ammonia from the exhaust of each RTO
- Determine the opacity of emissions at each RTO exhaust

Testing will be conducted by Airtech Environmental Services Inc. Testing is intended to meet the requirements of Atlas and the Wisconsin Department of Natural Resources (WDNR), Construction Permit (12-MHR-176). Testing will be coordinated by the following personnel:

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### Methodology

To convert the measured pollutant concentrations described below to mass emission rates, the volumetric gas flow rate through each test location will be determined using EPA Methods 1, 2, 3, and 4. Flow rates will be determined concurrent with each test run.

#### *Destruction Efficiency Methodology*

The DE of the paired oxidizer system will be calculated by measuring the total hydrocarbons (THC) simultaneously at the inlet and outlet of each unit. EPA Method



25A will be used to determine the THC concentration at each test location. Because methane is included in Method 25A and is an exempt VOC, the methane concentration at each test location will be determined using EPA Method 18. The methane emission rate will be subtracted from the THC emission rate to give a total non-methane hydrocarbon (TNMHC) emission rate. Calculation of DE will be based on the TNMHC emission rates from the inlet and outlet of the unit. Analysis for methane will be performed on-site using gas chromatography.

#### ***Particulate Methodology***

EPA Method 5 combined with EPA Method 202 will be used to determine the PM and CPM concentrations at each RTO Exhaust. In EPA Methods 5/202, a sample of the gas stream will be withdrawn isokinetically from the stack and the filterable PM will collect in a glass lined probe and on a glass fiber filter. The condensable PM will pass through the probe and filter and collect in a dry impinger system. With this approach the total PM will be considered to be the sum of the filterable PM and the CPM.

#### ***Opacity Methodology***

The procedures found in EPA Method 9 will be used to visually determine the opacity of emissions from each test location. In Method 9 the opacity of emissions are determined by a certified observer. Readings are taken at fifteen (15) second intervals for the duration of each test run.

#### ***NO<sub>x</sub> Methodology***

EPA Method 7E will be used to determine the NO<sub>x</sub> concentration at each RTO exhaust. In Method 7E, a sample of the exhaust gas will be withdrawn from the source at a constant rate through a heated, stainless steel probe, a heated glass fiber filter and a heated Teflon sample line. All heated components will be maintained at a temperature of at least 250°F to prevent the condensation of moisture. The sample gas stream will then be routed through a gas conditioning system designed to unobtrusively remove the moisture before the sample gas is vented to the NO<sub>x</sub> analyzer. The analyzer will be calibrated with EPA Protocol 1 mixtures of NO in a balance of nitrogen.

#### ***Formaldehyde and Phenol Methodology***

Formaldehyde and phenol sampling will be conducted using NCASI Method CI/WP-98.01. A sample of the stack gas will be withdrawn from the source and passed through a series of chilled impingers containing HPLC grade water. One (1) aliquot of the impinger contents will be returned to Airtech and analyzed for formaldehyde. Another aliquot of the impinger contents will be sent to Enthalpy Analytical and analyzed for Phenol.

#### ***Ammonia Methodology***

Conditional Test Method 027 (CTM-027) will be used to determine the ammonia concentration at the test locations. A sample of the gas stream will be withdrawn from the stack and through a series of glass impingers containing a dilute sulfuric acid solution. The contents of the impingers will be recovered and analyzed using ion chromatography (IC).

### *CE Methodology*

EPA Alternative Method 012 (ALT-012) as well as EPA Method 320 will be referenced in determining the CE of each Bulk Material mixing tower. The ALT-012 method involves injecting a tracer gas at a precise and known mass flow rate. EPA Method 320 Fourier Transform Infrared (FTIR) Spectroscopy will then be used to measure the concentration of the tracer component downstream of the injection points.

The tracer gas Method ALT-012 is performed by injecting a known concentration of a gas not otherwise present in the gas stream into the duct at a known mass flow rate. The tracer gas is expected to be sulfur hexafluoride (SF<sub>6</sub>). The flow rate of the tracer gas will be metered simultaneously into several different points along the mixing tower using a mass flow meter. The tracer gas concentration is then measured downstream of the injection point (RTO inlet).

The tracer gas concentration at RTO inlet will be determined using EPA Method 320. A sample of the gas stream will be continuously withdrawn from the test location and analyzed using a continuous FTIR gas analysis system. The sample gas will be withdrawn from the RTO Inlet at a constant rate through a stainless steel probe, a glass fiber filter and a Teflon sample line. The probe, filter and sample line will be operated at a temperature of at least 250 °F to prevent the condensation of moisture. The sample gas will then pass to the FTIR spectrometer gas cell. Results from the analyzer will be determined on a “wet” volume basis.

The CE of the mixing tower will be calculated by comparing the measured tracer gas emission rate at the RTO inlet to the actual mass of tracer gas injected into the mixing tower.

Capture efficiency test precision will be demonstrated using the data quality objective (DQO) or lower confidence limits (LCL) approach. If satisfying the DQO approach, sufficient test runs need to be performed to demonstrate that 95 percent of the time when DQO is met, the capture efficiency is within five (5) percent of the average measured value. The lower confidence limit approach is generally used by sources that are well above their capture efficiency requirement. With the LCL approach less precision (fewer test runs) is acceptable. The lower confidence limit approach requires that the LCL be greater than the minimum capture efficiency requirement.

With either approach a minimum of three (3), sixty-minute test runs will be performed. Additional runs may be required to satisfy DQO or LCL precision requirements.

### **Parameters**

The following gas parameters will be determined at each test location during each test run, except where noted:

- gas velocity
- duct temperature
- moisture concentration
- oxygen concentration
- carbon dioxide concentration
- particulate matter concentration (RTO Exhausts)
- nitrogen oxides concentration (RTO Exhausts)
- opacity of emissions (RTO Exhausts)
- ammonia concentration (RTO Exhausts)
- methane concentration
- total hydrocarbon concentration
- condensable particulate matter (RTO Exhausts)
- formaldehyde concentration (RTO Exhausts)
- phenol concentration (RTO Exhausts)

## Test Schedule

The following test schedule outlines the work to be performed. Testing is tentatively scheduled for the week of June 23, 2013 pending approval from WDNR.

Day	Location	Activity	Test Methods	No. Runs	Duration
6/23	Taylor, Wisconsin	Travel to job site  Set up equipment			
6/24	RTO 1 In and Out	Perform DE testing	1, 2, 3, 4, 18 and 25A	3	60 min
	RTO 1 Outlet	Perform testing	1, 2, 3, 4, 7E, CTM-027 and CI/WP-98.01	3	60 min
6/25	RTO 1 Outlet	Perform testing	1, 2, 3, 4, 5/202 and 9	3	60 min
	Mixing Tower 1	CE Testing	1, 2, 3, 4, ALT- 012 and 320	3	60 min
6/26	RTO 2 In and Out	Perform DE testing	1, 2, 3, 4, 18 and 25A	3	60 min
	RTO 2 Outlet	Perform testing	1, 2, 3, 4, 7E, CTM-027 and CI/WP-98.01	3	60 min
6/27	RTO 2 Outlet	Perform testing	1, 2, 3, 4, 5/202 and 9	3	60 min
	Mixing Tower 2	CE Testing	1, 2, 3, 4, ALT- 012 and 320	3	60 min
		Breakdown test equipment and return travel			

## Methodology

### Method Listing

The following test methods will be referenced for the test program. These methods can be found in 40 CFR, Part 60, Appendix A. In addition, the procedures outlined in the USEPA guidance document entitled “Guidelines for Determining Capture Efficiency” will be referenced. The following individual methods will be used:

Method 1	Sample and velocity traverses for stationary sources
Method 2	Determination of stack gas velocity and volumetric flow rate (Type S pitot tube)
Method 3	Gas analysis for the determination of dry molecular weight
Method 4	Determination of moisture content in stack gases
Method 5	Determination of particulate matter emissions from stationary sources
Method 7E	Determination of nitrogen oxides emissions from stationary sources (instrumental analyzer procedure)
Method 9	Visual determination of the opacity of emissions from stationary sources
Method 18	Measurement of gaseous organic compound emissions by gas chromatography
Method 25A	Determination of total gaseous organic concentration using a flame ionization analyzer
Method 202	Dry impinger method for determining condensable particulate emissions from stationary sources
Method 320	Measurement of vapor phase organic and inorganic emissions by extractive Fourier Transform Infrared (FTIR) spectroscopy

In addition, the following EPA approved test methods will also be referenced. These Methods can be found on the EPA Technology Transfer Network web site.

ALT 012	An alternate procedure for stack gas volumetric flow rate determination (tracer gas)
CTM 027	Procedure for collection and analysis of ammonia in stationary sources

Finally, the following test method developed by the National Council for Air and Stream Improvement (NCASI) will also be referenced.

CI/WP-98.01	Chilled impinger method for use at wood products mills to measure formaldehyde, methanol and phenol
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## Method Descriptions

### *EPA Method 1*

EPA Method 1 will be used to determine the suitability of each sampling location and to determine the sampling points used for the volumetric flow rate determinations. Each test location must conform to the minimum requirements of being located at least two diameters downstream and at least 0.5 diameters upstream from the nearest flow disturbance.

The RTO inlet test locations are round vertical ducts with a diameter of 22.5 inches. Two test ports are located 7.0 duct diameters downstream and 3.2 diameters upstream from the nearest flow disturbances. Six sample points per test port will be traversed for each velocity determination. A cross section of the sampling location, showing the sample points, can be found in Figure 1 of the Appendix.

The RTO Outlet test locations are round Vertical ducts with a diameter of 34.0 inches. Two test ports are located 5.3 duct diameters downstream and 5.3 diameters upstream from the nearest flow disturbances. Six sample points per test port will be traversed for each velocity determination. A cross section of the sampling location, showing the sample points, can be found in Figure 2 of the Appendix.

### *EPA Method 2*

EPA Method 2 will be used to determine the gas velocity through each test location. An S-type pitot tube and an incline oil manometer will be used for the determination at each test location. The manometer will be leveled and “zeroed” prior to each test run. The sample train will be leak checked before and after each run by pressurizing the high side and creating a 3-inch deflection on the manometer. The leak check is considered valid if the manometer remains stable for 15 seconds. This procedure will be repeated on the negative side by using vacuum. The velocity head pressure and gas temperature will then determined at each point specified in Method 1. The static pressure of each duct will be measured using a water filled U-tube manometer. In addition, the barometric pressure will be measured and recorded. A diagram of the Method 2 apparatus is shown in Figure 3.

The values measured in Method 2 along with the measurements made in Methods 3 and 4 are used to calculate the volumetric flow rate through each test location

### *EPA Method 3*

The carbon dioxide and oxygen content at each test location will be determined using EPA Method 3. The carbon dioxide content and oxygen content will be used to calculate the molecular weight of the gas stream, which will be used in the volumetric flow rate calculations. The remainder of the gas stream will be assumed to be nitrogen since the quantity of other components in the gas stream are negligible for the purposes of calculating molecular weight. A gas sample will be collected into a Tedlar bag from the

back of the EPA Method 4 train for the duration of each test run. Analysis will be performed using an Orsat gas analyzer.

#### ***EPA Method 4***

The moisture content at each test location will be determined using EPA Method 4. A known volume of sample gas will be withdrawn from the source and the moisture will be condensed and measured. The dry standard volume of the sample gas will then be compared to the volume of moisture collected to determine the moisture content of the sample gas. A schematic of the moisture sample train is shown in Figure 4.

To condense the water vapor the gas sample will pass through a series of four impingers. The first two impingers will each contain 100 ml of water. The third impinger will be empty and the fourth will contain a known weight of silica gel to absorb any remaining water vapor. The sample train will be leak checked prior to the test run by capping the probe tip and pulling a vacuum greater than the highest vacuum expected during the test run. A leak check will be considered valid if the leak rate is less than 0.02 cubic feet per minute or four percent of the average sample rate.

Sample gas will then be withdrawn from the source at a rate not exceeding 0.75 cubic feet per minute such that a minimum sample volume of 21 dry standard cubic feet will be collected. The volume of dry gas exiting the gas condenser system will be measured with a dry gas meter. After leaving the dry gas meter the sample stream will pass through an orifice which will be used to meter the flow rate through the sample train. The pressure drop across the orifice will be measured with an incline plane oil manometer. The gas meter reading, gas meter inlet and outlet temperatures, gas meter static pressure and pump vacuum will be recorded every five minutes during each test run. Each test will be 60 minutes in duration.

After the test run the sample train will be leak checked at the highest vacuum encountered during the test run. The amount of water collected in the condenser system will be measured volumetrically with a graduated cylinder and the silica gel weight gain will be determined gravimetrically. The net weight gain of water will be converted to a volume of wet gas and then compared to the amount of dry gas sampled to determine the moisture content. The moisture content will be used, along with the oxygen and carbon dioxide content determined by EPA Method 3, for the calculation of the volumetric flow rate.

#### ***EPA Methods 5/202***

The PM concentrations at the applicable test locations will be determined using EPA Methods 5/202. In EPA Methods 5/202, a sample of the gas stream will be withdrawn isokinetically from the test location. FPM will be collected in the nozzle, probe, connecting glassware and filter. CPM in the sample gas will pass through the filter and be collected in a gas condenser system. The weight of FPM and CPM collected with the sample train combined with the volume of dry gas withdrawn from the sample location will be used to calculate the PM concentrations. A schematic of the moisture sample train is shown in Figure 5.

To prevent contamination, all components of the sample trains will be constructed of glass with no metal connections. Prior to testing all the components of the Method 5 portion of the sampling train will be cleaned using detergent and then rinsed with water, deionized ultra filtered (DIUF) water and finally with acetone. For the EPA Method 202 portion of the sampling train all the components will be cleaned using detergent and then rinsed with water, DIUF water, acetone and finally with hexane. After drying, all components will be sealed with parafilm, aluminum foil or Teflon tape.

The EPA Method 5 portion of the sampling train will consist of a glass nozzle, a glass sample probe and a glass fiber filter. The probe and filter will be maintained at a temperature of 248°F (+/- 25°F).

After exiting the EPA Method 5 portion of the sampling system, the sample gas will pass through a glass coil condenser and then through a series of four (4) glass impingers. The condenser will be cooled with a water recirculation pump that is placed in a water bath. The recirculation pump and coil condenser will be used to maintain the gas temperature between 65°F and 85°F at the exit of the CPM filter. The first two (2) impingers will initially be empty. A Teflon fiber condensable PM filter will be located between the second and third impingers. The third impinger will initially contain 100 ml of water. The fourth impinger will contain a known quantity of silica gel to absorb any remaining water vapor. The dry gas exiting the moisture condenser system will then pass through a sample pump and a dry gas meter to measure the gas volume. After leaving the dry gas meter the sample stream will pass through an orifice which will be used to meter the flow rate through the sample train. The pressure drop across the orifice will be measured with an incline plane oil manometer.

Whatman 934-AH glass fiber filters will be used as the substrate for the filterable PM sampling. The filter will be loaded into a glass filter holder with a Teflon support screen that will be cleaned and prepared in the same manner as the other components of the EPA Method 5 portion of the sample train. Prior to the test run the filters will be desiccated for at least 24 hours and then weighed to the nearest 0.0001 gram (g) until a constant weight is achieved. The weight of the filter will be considered to be constant when two consecutive weights taken at least six hours apart are within 0.0005g of each other.

The probe liner will be thoroughly pre-cleaned with acetone and the probe wash will be saved as a quality assurance check. The sample train will be leak checked prior to the test run by capping the probe tip and pulling a vacuum of at least 15 inches Hg. A leak test will be considered valid if the leak rate is below 0.02 cfm. When not in operation or inside the stack, the nozzle will be sealed with Teflon tape.

The probe tip will be placed at the first of the sample points determined in Method 1. The velocity at the sample point will be determined using Method 2 by reading the velocity pressure from the oil manometer. Sample will be withdrawn from the source at a rate such that the velocity at the opening of the nozzle matches the velocity of the stack

gas at the sample point (isokinetically). During the test run the train will be moved to each of the Method 1 sample points. The sample time at each point will be calculated based on the number of sample points and the run time. The gas velocity pressure, gas meter reading, gas meter inlet and outlet temperatures, gas meter orifice pressure and pump vacuum will be recorded for each sample point.

After the test run the sample train will be leak checked at the highest vacuum encountered during the test run. The sampling train will be moved to the on-site laboratory and purged with zero grade nitrogen at a nominal flow rate of at least fourteen (14) liters per minute (lpm) for a period of at least 60 minutes. The nozzle, probe and front half of the filter holder will be rinsed with acetone and the rinse saved in a pre-cleaned 250 ml glass sample jar equipped with a Teflon-lined lid. The glass fiber filter will be removed from the filter holder, transferred to a Petri dish and sealed.

Upon completion of the purge, the contents of the first two impingers will be transferred to a pre-cleaned 950 ml sample jar equipped with a Teflon-lined lid. The condenser coil and all connecting glassware up to and including the front half of the CPM filter will be rinsed twice with DIUF water and added to the sample jar. An acetone rinse of the above glassware will be performed and saved in a separate pre-cleaned 500ml sample jar equipped with a Teflon-lined lid. Finally, two (2) rinses of the above components will be performed using hexane and these rinses will be added to the acetone container. The CPM filter will be removed from the filter holder and placed in a 20 ml glass sample jar.

Analysis of all sample fractions will be performed at the Airtech laboratory located in Elk Grove Village, Illinois. The acetone rinses from the EPA Method 5 portion of the sampling train will be transferred to tared beakers, evaporated to dryness under ambient temperature and pressure conditions, desiccated for 24 hours and weighed to a constant weight. A weight will be considered constant when the difference between two consecutive weights, taken a minimum of six hours apart, is less than or equal to 0.0005 g. The weight gain of the probe rinses and glass fiber filter will yield the total weight of filterable PM collected during sampling.

Inorganic extraction of the CPM filter will be performed by placing the filter into an extraction tube with DIUF water and placing it into a sonication bath for a minimum of two (2) minutes. This extraction will be done a total of three (3) times and the water used each time will be added to the impinger water container. After inorganic extraction of the CPM filter, an organic extraction of the impinger water will be performed. The entire contents of the impinger water sample fraction will be placed in a separatory funnel. A 30 ml aliquot of hexane will be added to the funnel and the funnel contents will be thoroughly mixed. The organic layer will then allowed to separate from the water and removed from the funnel into the acetone and hexane sample jar. This procedure will be conducted a total of three (3) times to complete the extraction.

The inorganic contents of the separatory funnel will then be transferred into a beaker and evaporated, at an elevated temperature, to final volume of no less than 10 ml. The

remaining liquid will be evaporated to dryness at ambient temperature. The beaker will be desiccated for at least 24 hours and then weighed to a constant weight as defined previously.

Organic CPM extraction of the filter will be performed by placing the inorganic extracted filter into an extraction tube with hexane and placing it into a sonication bath for a minimum of two (2) minutes. This extraction will be done a total of three (3) times and the hexane used will be added to the acetone/hexane container. The contents of this container will be transferred into a beaker and evaporated to a volume not less than 10 ml. The remaining fraction will be then evaporated to dryness at ambient temperature and pressure. The beaker will be desiccated for 24 hours and then weighed to a constant weight.

The weight differences for the organic and inorganic fractions will be combined to determine the total CPM collected. All fractions of the CPM analysis will be adjusted for the appropriate field blank values.

#### ***EPA Method 7E***

The nitrogen oxides concentration at the RTO Exhausts will be determined using EPA Method 7E. A sample of the gas stream will be continuously withdrawn from each test location and analyzed using a reference method continuous emission monitoring system. A diagram of the sampling system may be found in Figure 6 of the Appendix.

The sample gas will be withdrawn from each test location at a constant rate through a heated stainless steel probe, filter and a heated Teflon sample line. The probe, filter and sample line will be operated at a temperature of at least 250 °F to prevent the condensation of moisture. The sample gas is then directed to an M & C Type EC gas cooler system. The gas cooler consists of stages designed to unobtrusively lower the dewpoint of the sample gas to 35 °F, thus removing the moisture. The dry gas will then be vented to the nitrogen oxides analyzers. Results from these analyzers will be determined on a “dry” basis. The gas analyzers to be used for this project are listed in the table below.

Parameter	Manufacturer	Model Number	Operating Principle	Units	Range
Nitrogen Oxides	Thermo Environmental	42C	Chemi-luminescence	(ppmdv)	0-100

An NO<sub>2</sub> to NO conversion efficiency test will be performed on the NO<sub>x</sub> analyzer that will be used for the test project. A mid-level calibration gas will be diluted approximately 1:1 with ambient air in a tedlar bag. The gas bag content will then be run through the nitrogen oxides analyzer. The instrument response remained stable at the highest value

observed for a period of 30 minutes in order to demonstrate a 100 percent NO<sub>2</sub> to NO conversion efficiency.

Prior to sampling, a calibration error test will be performed. The zero and high-range calibration gases will be introduced directly into the analyzer. The analyzer will then be adjusted to the appropriate values. The mid or low-range gases will then be introduced to the analyzer and the measured values and recorded. The measured values for each calibration gas will then be compared to the calibration gas values and in all cases the differences must be less than the method requirement of two percent of the span value.

After each test run the instrument drift for each analyzer will be determined by introducing the zero and mid-range calibration gases into the sampling system. The measured response will then be compared to the values from the previous test run to determine the analyzer drift. For all test runs, the analyzer drift must be less than the method requirement of two percent of the span value.

#### ***EPA Method 9***

The opacity of emissions from each RTO Exhaust will be determined according to Method 9. A certified observer positioned with a line of sight perpendicular to the plume direction determined the opacity. The observer will view the plume with the sun oriented in the 140° sector of the observer's back. A minimum distance equal to three times the height of the stack will be maintained between the observer and the smoke plume. The observer's line of sight will not include more than one plume.

Readings will be taken at 15-second intervals for a duration of 60 minutes per run. Between readings, the observer looked away from the plume to rest his eyes. Wind speed and direction will be recorded as well as descriptions of the plume, background and weather conditions.

#### ***EPA Method 18***

EPA Method 18 will be used to determine the concentration of methane in the gas stream. In Method 18, a sample of the gas stream is withdrawn from the source, and its major components are separated, using a gas chromatograph (GC). The individual components are then quantified using a flame ionization detector (FID).

The Tedlar bag sample used for the Method 3 analysis will also be used for the Method 18 analysis. A portion of the gas sample will be injected into the Hewlett Packard 5890 II GC using a 1.0 ml gas sample valve. The components of the gas sample will be separated using a 30m AT-1 column with a 3.0um film thickness. Nitrogen will be used as a carrier gas to pass the sample through the column. After exiting the column the separated sample components, along with the carrier gas, will pass through the FID. The retention time and area of each peak will be monitored using HP Chemstation computer integration software. The identity of each peak will be determined by comparing the retention time of the sample peak with the retention time determined by analyzing known standards.



The GC will be calibrated using compressed gas standards that contain known concentrations of methane in a balance of nitrogen. A minimum of three standards of different concentrations will be analyzed. The standards will be selected such that they bracket the expected concentration at each test location. A diagram of the Method 18 sample train is shown in Figure 7 of the appendix

Results will be calculated by comparing the areas of the standards to the area of the gas sample using linear regression analysis or an average response factor. Results will be expressed in ppm of methane.

#### ***EPA Method 25A***

The total VOC concentration at each test location will be determined using the procedures found in EPA Method 25A. In EPA Method 25A, a sample of the gas stream is withdrawn from each test location at a constant rate through a Teflon probe and sample line. The sample line is heated to 250°F to prevent the condensation of water vapor or organics. The sample gas then passes directly into a flame ionization analyzer (FIA). The FIAs to be used on this project are JUM Engineering Model 3-300A. Zero grade hydrogen is used to fuel the instrument. Zero air and EPA Protocol calibration gases of propane in nitrogen will be used for all calibration checks. The Method 25A sampling apparatus is shown in Figure 8.

Prior to sampling a calibration error test will be performed. The zero gas and high level gas will be introduced to the analyzers at the calibration valve assembly and the analyzers set to the appropriate levels. The mid and low level gases will then be introduced to the analyzers and the predicted response compared to the actual response of the analyzers. The difference must be less than the minimum requirement of 5 percent of the calibration gas value. After each test run, the instrument drift will be determined by introducing the zero gas and one upscale calibration gas into the system at the probe tip, while making no adjustments to the analyzer. For all test runs the drift must be less than the minimum requirements of 3 percent of the span value.

#### ***EPA Method 320***

The SF<sub>6</sub> concentration at the RTO Inlet will be determined using EPA Method 320. A sample of the gas stream will be continuously withdrawn from the test location and analyzed using a continuous FTIR gas analysis system.

The sample gas will be withdrawn from the test location at a constant rate through a stainless steel probe, a glass fiber filter and a Teflon sample line. The probe, filter and sample line will be operated at a temperature of 250 °F to prevent the condensation of moisture.

The sample gas will then pass through an M & C Type EC gas cooler system. The gas cooler consists of two separate stages designed to lower the dewpoint of the sample gas to 35 °F, thus removing the moisture. The dry gas will then be directed to the FTIR

spectrometer gas cell. Results from the analyzer will be determined on a “dry” volume basis.

The FTIR gas analyzer that will be used for this project is an MKS MultiGas FTIR analyzer and a schematic of the sampling system can be found in Figure 9 in the Appendix.

Prior to testing, the detection limit (DL) and analytical uncertainty (AU) will be determined for each constituent. The potential interferants for the analytes being tested will be determined. The optical configuration that can measure all of the analytes within the absorbance range of 0.01 and 1.0 will be determined. The sample system will be assembled and allowed to reach stable operating temperatures and flow rates. A sample interface leak check will be performed. Nitrogen or zero air will be directed to the FTIR gas cell in order to determine a background spectrum. A sample spectrum will then be recorded in succession. The peak to peak and RMS noise in the resultant spectrum in the wavelength region(s) to be used for the target compound analysis will be measured and recorded.

A Calibration Transfer Standard (CTS) will be introduced into the system and two spectra will be recorded at least two minutes apart. As long as the second spectrum is no greater than the first and within the uncertainty of the gas standard, it will be used as the CTS spectrum.

A QA spike will be performed by introducing a certified standard for SF<sub>6</sub> into the sampling system. Spectra will be recorded for three independent spiked samples and the concentration of the spike will be calculated. The average spiked concentration must be within 70% and 130% of the expected concentration.

After all required pre-test procedures have been performed, stack gas will be sampled continuously. Sample interferograms, processed absorbance spectra, background interferograms, CTS sample interferograms, and CTS absorbance spectra will be recorded. Sample conditions, instrument settings, and test records will also be recorded throughout the test. If signal transmittance changes by 5 percent or more in any analytical spectral region, a new background spectrum will be obtained. A new CTS spectrum will be obtained after each sampling run. The post-test CTS spectrum will be compared to the pre-test spectrum. The peak absorbance from each spectrum must be within 5% of the mean value.

A system recovery check using the analyte spiking technique will be performed prior to testing. First, some of the effluent gas will be sampled in order to determine native concentration of target analytes. The analyte spike calibration gas will then be introduced to the FTIR gas cell only, and the results will be determined using the analytical algorithm. Results from the calibration gas will be recorded and compared to the certified value of the calibration gas. For reactive condensable gases such as hydrogen chloride (HCl), ammonia (NH<sub>3</sub>), and formaldehyde (HCHO), the results must



be within 10% or 5 ppm. The analyte spike calibration gas will then be directed through the entire sampling system and allowed to mix with effluent gas sample at a known flow rate. The flow ratio of calibration gas to ambient air or source effluent shall be no greater than 1:10 (one part calibration gas to ten parts total flow) for the determination of sample recovery. The concentration of the resultant spiked gas should be within 50% to 150% of the measured value of effluent sample. The dilution factor of the analyte spike concentration gas will be calculated and the bias between the observed spike value and the expected response will be determined. The percent recovery of the spiked analytes will be calculated. Spike recovery results must meet the data quality objectives of the test program.

### ***CTM 027***

EPA Conditional Test Method 027 will be used for determining the ammonia concentration at each test location. In Method 027, a gas sample is withdrawn isokinetically from the source and passed through a series of chilled impingers containing an absorbing solution. The adsorbing solution is then analyzed for ammonia using ion chromatography. A diagram of the sampling system may be found in Figure 10 of the Appendix.

The sample probe used will consist of a glass probe liner and glass nozzle. Sample gas will pass through the probe assembly and then will pass through a glass fiber filter. The probe and filter will be operated at a temperature of 248°F, +/- 25°F to prevent the condensation of moisture. After passing through the probe and filter assemblies, the sample gas will pass through a series of four glass impingers. After exiting the impinger system, the gas stream will pass through a sample pump and into a dry gas meter, where the gas volume is measured.

Prior to testing, the first and second impingers will be loaded with 100 ml each of 0.1N sulfuric acid (H<sub>2</sub>SO<sub>4</sub>). The third impinger will remain empty. The fourth impinger will contain a known quantity of silica gel. After assembly, the sample train will be leak checked by capping the probe tip and pulling a vacuum greater than the highest vacuum expected during the test run. A leak check will be considered valid if the leak rate is below the lesser of 0.02 cubic feet per minute or four percent of the average sample rate.

Sample train operation will follow the same procedures described in Method 5/202. The total run time will be 60 minutes. After each run the sample train will be leak checked at the highest vacuum encountered during the test run. The contents of the first three impingers will be collected and the impingers rinsed with deionized water. The rinses will be added to the impinger catch. The collected samples will then be analyzed on site using a Dionex Model ICS 90 ion chromatograph.

### ***Method CI/WP-98.01***

A sample of the gas stream will be withdrawn from the RTO Exhausts and the formaldehyde and Phenol in the sample gas stream will be collected in an impinger system containing distilled water. The quantity of the formaldehyde and Phenol

collected in the sample train combined with the volume of dry gas withdrawn from the stack will be used to calculate the formaldehyde concentration in the stack gas.

Prior to testing, the components will be washed using detergent and then rinsed with tap water and de-ionized water. After drying, all components will be sealed with parafilm or Teflon tape.

The sample probe will consist of a borosilicate glass liner. After exiting the probe, the sample gas will pass through a three-impinger condenser system. The first two impingers will each contain 15 ml of HPLC grade water. The third impinger will be empty. The dry gas exiting the moisture condenser system will then pass through a silica gel tube, a sample pump and a dry gas meter to measure the gas volume.

The sample train will be leak checked prior to the test run by capping the probe tip and pulling a vacuum of at least 15 in.Hg. A leak check will be considered valid if the leak rate is less than four percent of the average sample rate. When not in operation inside the stack, the probe tip will be sealed with Teflon tape.

The probe tip will be placed at the centroid of the source and sample gas will be withdrawn from the source at a constant rate. Sampling will be conducted at a single point of average velocity. The gas meter reading, gas meter inlet and outlet temperatures, gas meter pressure, and pump vacuum will be recorded every five minutes. Each test run will be 60 minutes in duration.

After the test run the impinger contents will be recovered and placed in a glass sample jar. The impingers will be rinsed three times with HPLC grade water and the rinses added to the sample jar. The impinger catch will be stored on ice for shipment to the laboratory.

## Description of Installation

### Sand Resin Coating Process

The testing is to be performed on the discharge of two separate parallel sand resin coating processes. Heated sand along with resin and a small amount of additives are mixed in the Batch Mixers. An aqueous hexamethylenetetramine solution is added to the Batch Mixers (P51 or P151) to cross-link the melted resin and begins cooling the coated sand. Each Batch Mix is 3,100 pounds (sand + resin). There are 11-12 batches run per hour. During the emission tests the process will be operated at this rate. Each batch is discharge into a Continuous Mixer (P52 or P152) which is designed to keep the process flowing as discrete particles. The Continuous Mixers convert the batch process into a continuous process. There are Recuperative Thermal Oxidizers or RTO's (C51 & C151) that are used to control emission from the above mentioned sources. During the stack test premium product (PRC-P) will be run to ensure the highest phenol, VOC and ammonia readings that the plant sees.

### Operational Parameters

In adherence to the permit conditions, some process operational data will be collected during the stack sampling runs. The information to be collected includes:

#### *Operating Conditions During the Test*

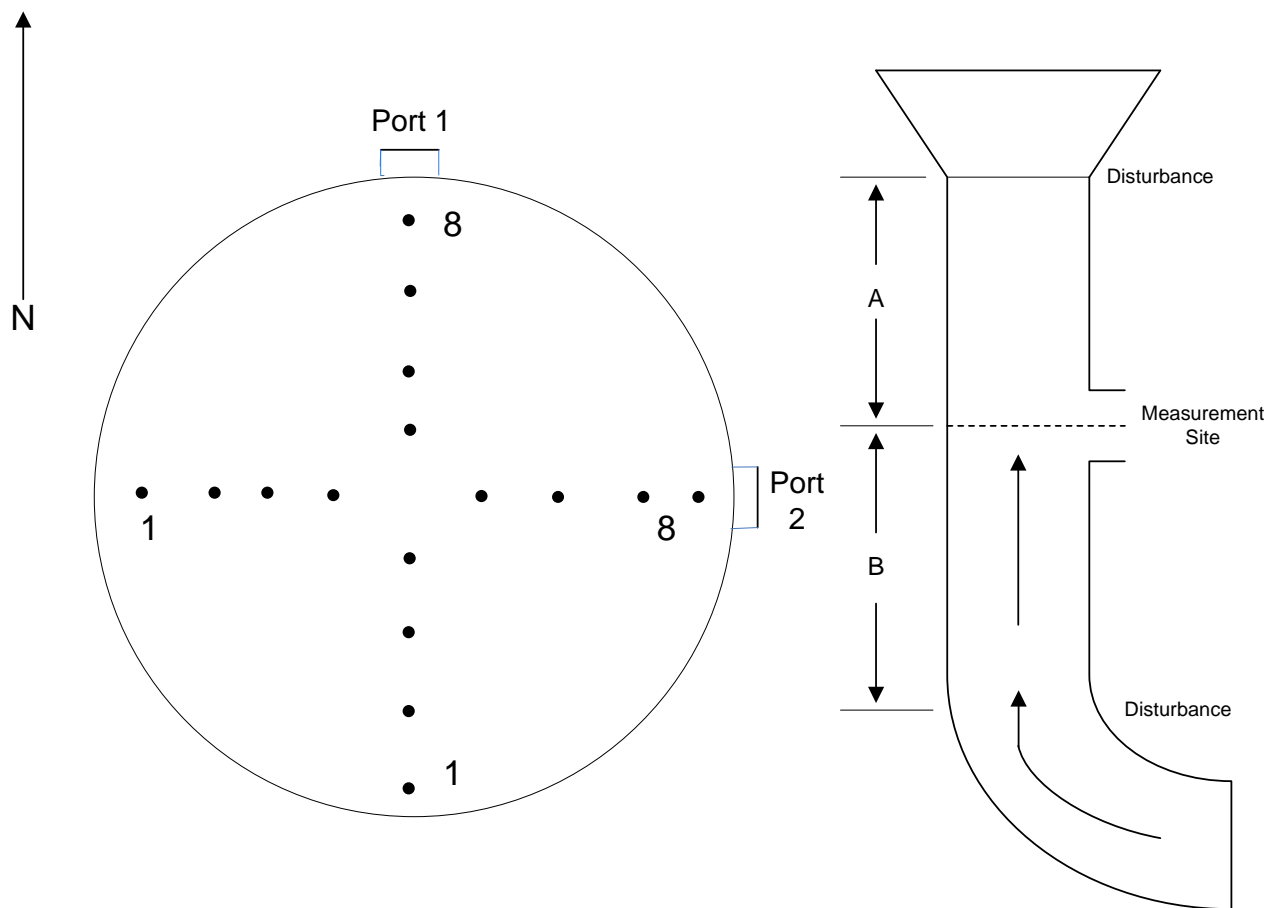
The process will be operated at normal conditions each test period which corresponds to 11-12 batches per hour at 3,100 lbs. per batch. During the stack test premium product (PRC-P) will be run to ensure the highest phenol and VOC readings that the plant sees.

#### *Monitoring and Verification of Operating Conditions*

During the tests the process operation will be monitored by Atlas Resin personnel. Pertinent operating data to document process operation will be supplied by Atlas Resin personnel. This will include number of batches as well as the operating temperature of the RTO's (C51 & C151). The hexa application rate, in pounds per hour, can be calculated from the number of batches/hr coupled with the hexa amount/batch in the PRC-P recipe. Based on the nitrogen oxides emission rate, in pounds per hour, derived from the testing; we will then be able to calculate nitrogen oxides emission rate, in pounds per pound of hexa.

## **Appendix**

### ***Figures***



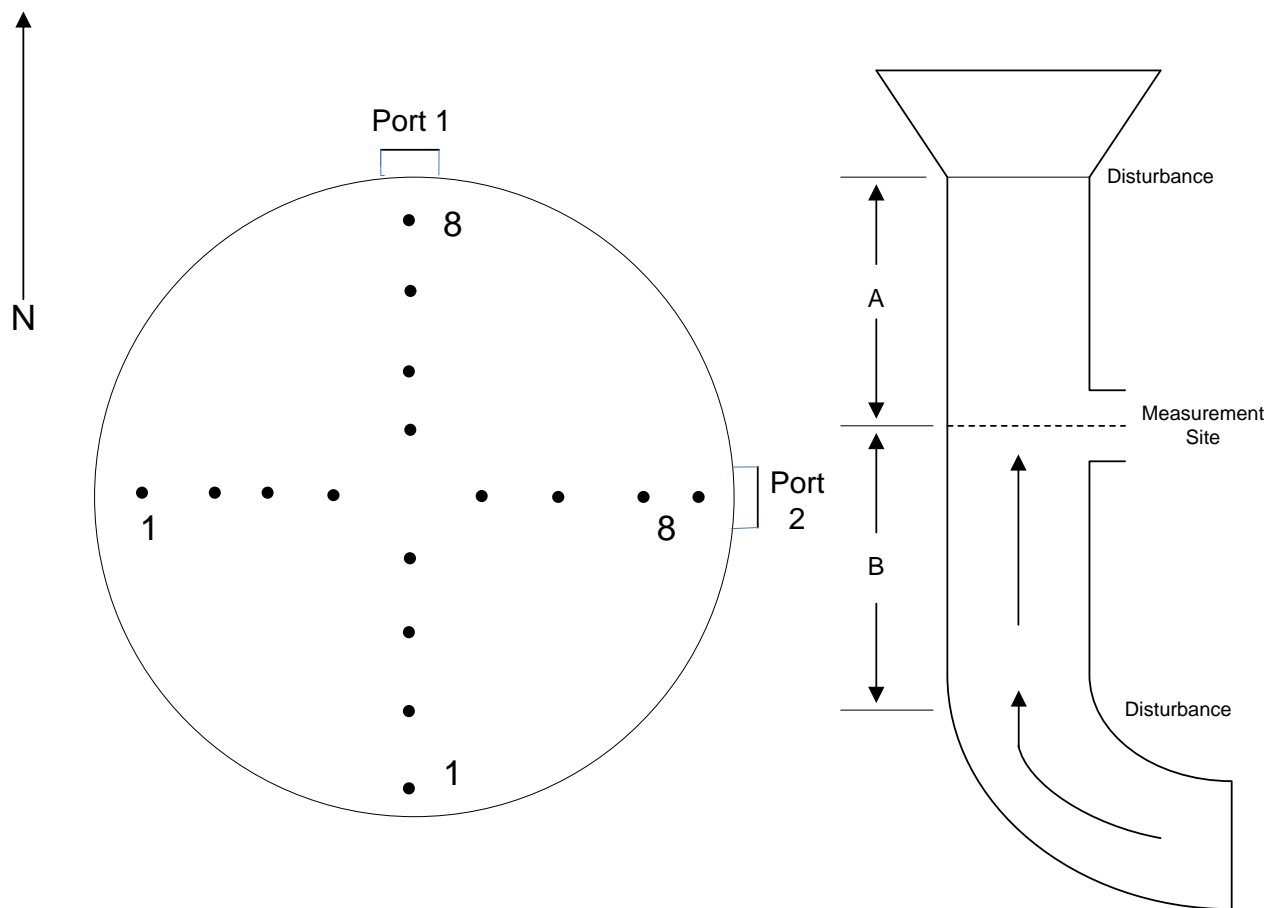
Diameter (in.) 22.5  
 Distance A (Duct Diameters) 3.2  
 Distance B (Duct Diameters) 7.0

Point	Distance From Wall (in.)
1	21.8
2	20.1
3	18.1
4	15.2
5	7.3
6	4.4
7	2.4
8	0.7

Cross Section of the  
 RTO Inlet Test Locations  
 Atlas Resins

Figure 1





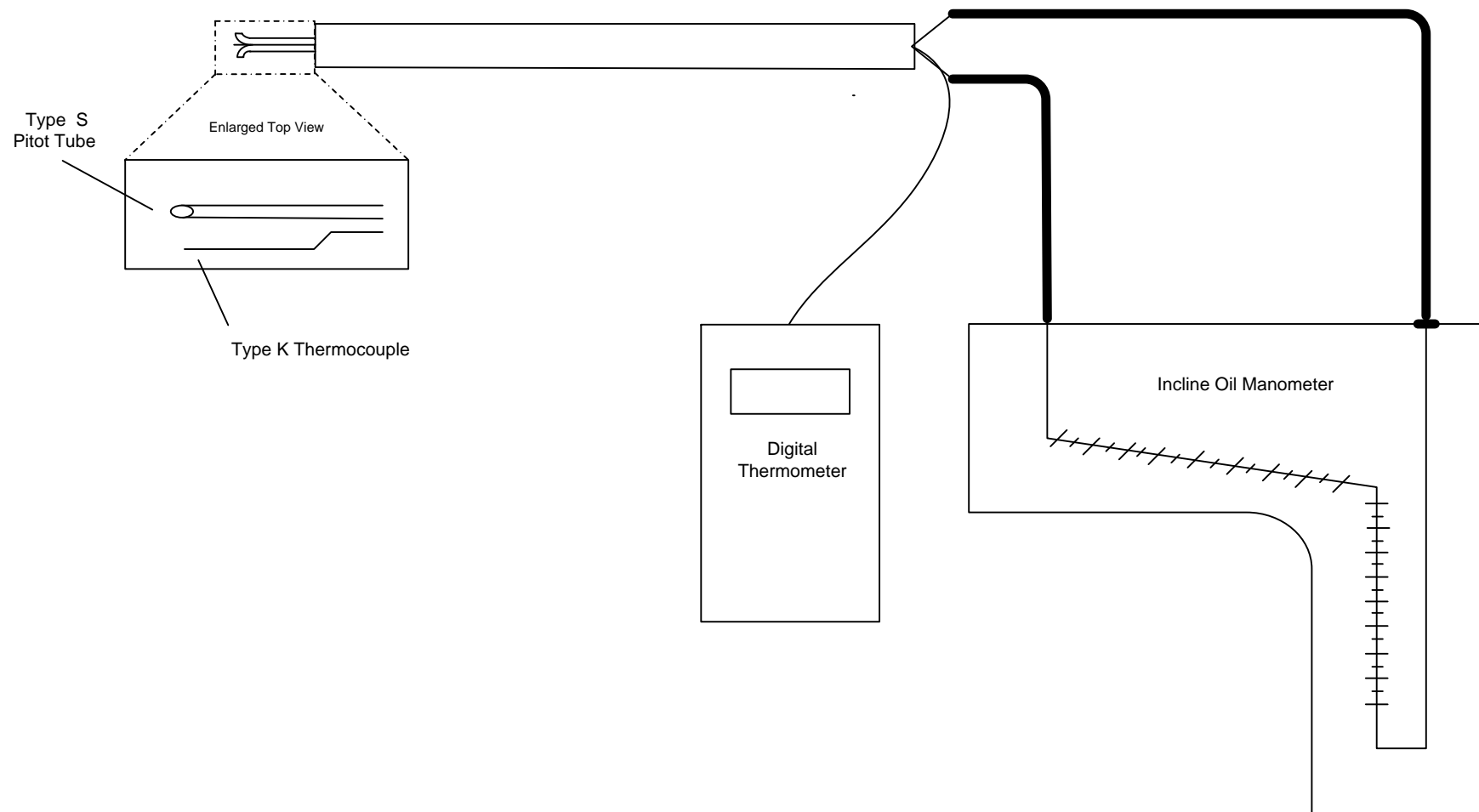
Diameter (in.)	34.0
Distance A (Duct Diameters)	5.5
Distance B (Duct Diameters)	5.5

Point	Distance From Wall (in.)
1	32.9
2	30.4
3	27.4
4	23.0
5	11.0
6	6.6
7	3.6
8	1.1

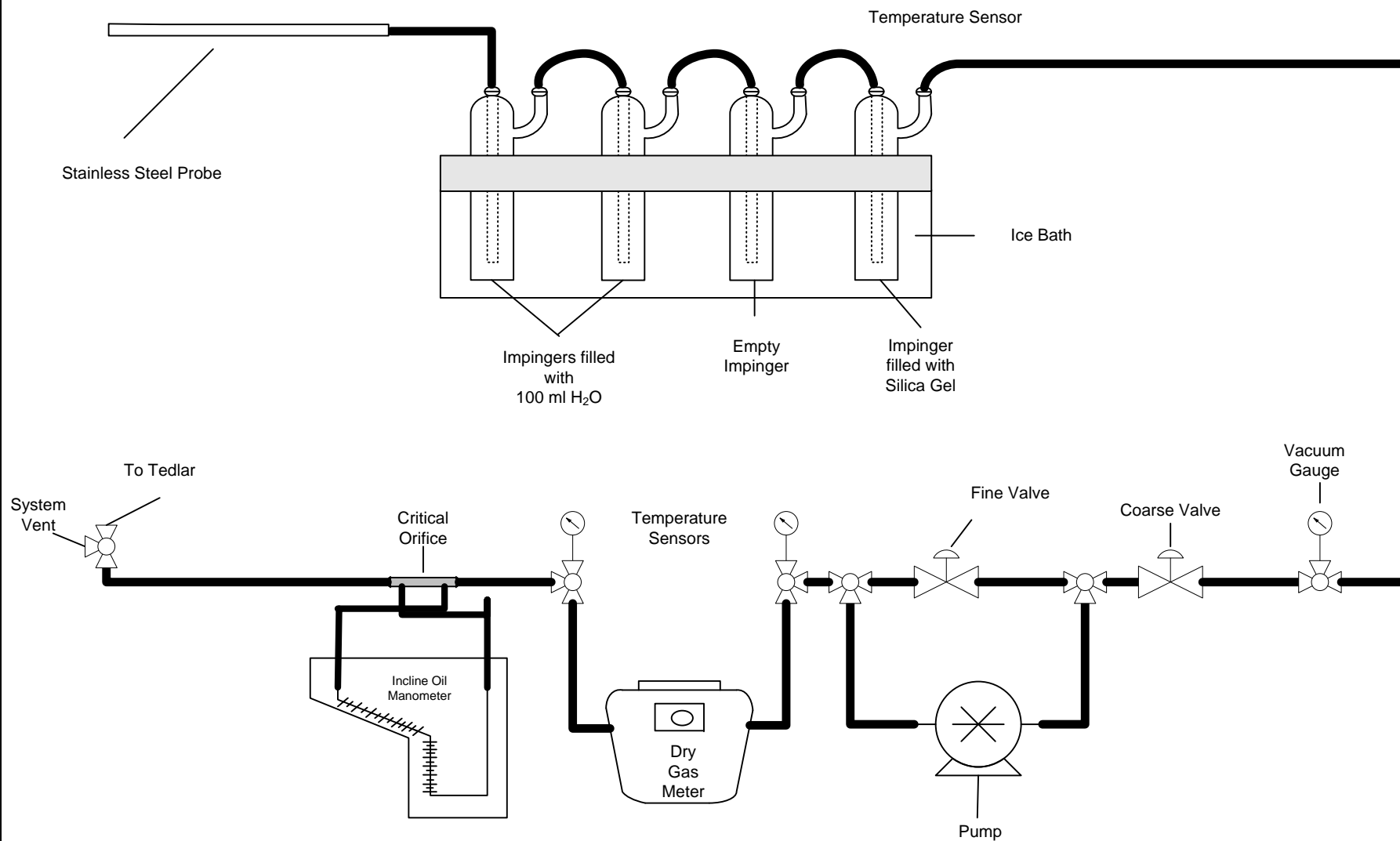
Cross Section of the  
RTO Outlet Test Locations  
Atlas Resin

Figure 2



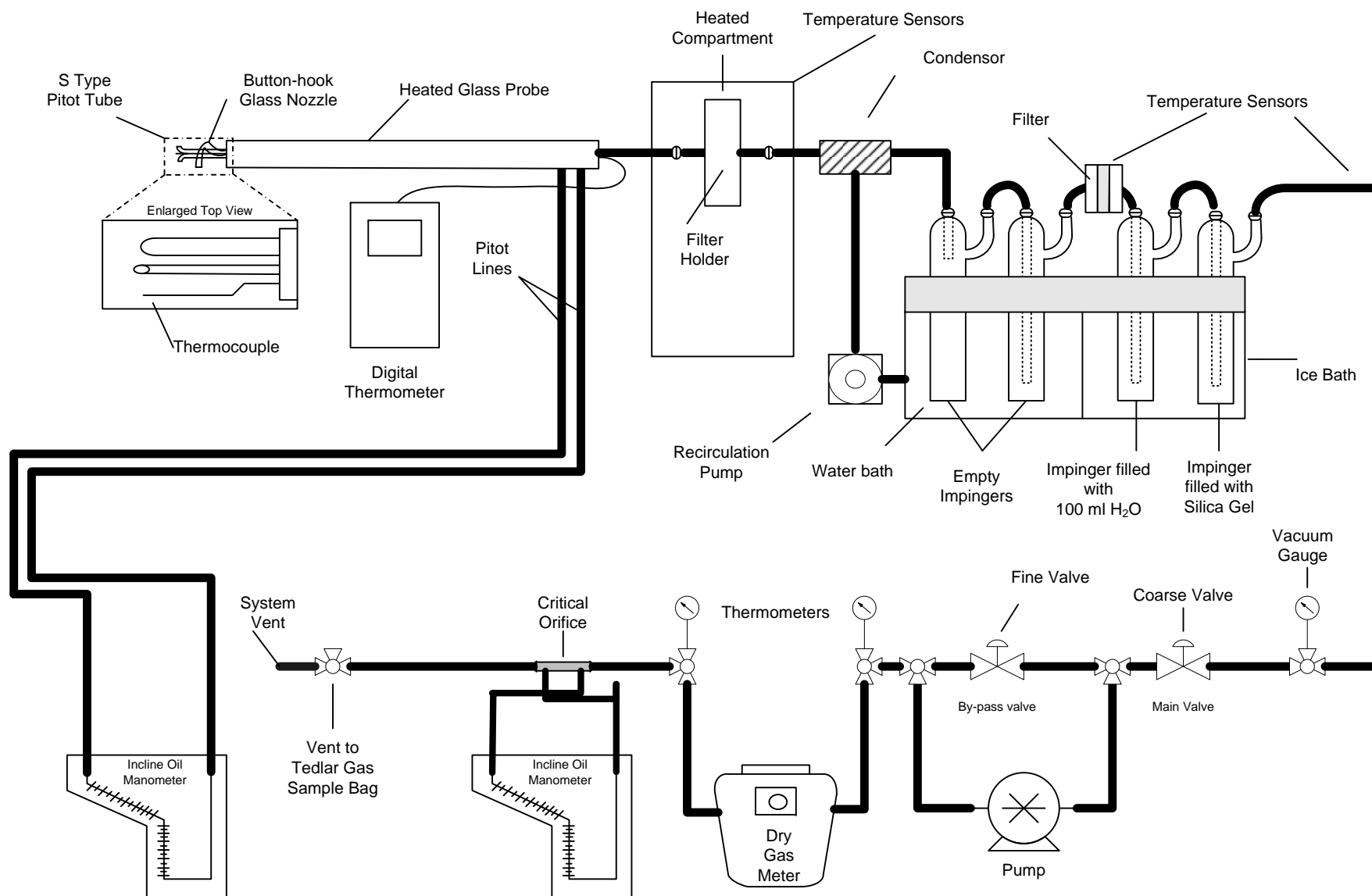


EPA Method 2:  
Type S Pitot Tube Assembly with Manometer  
Figure 3

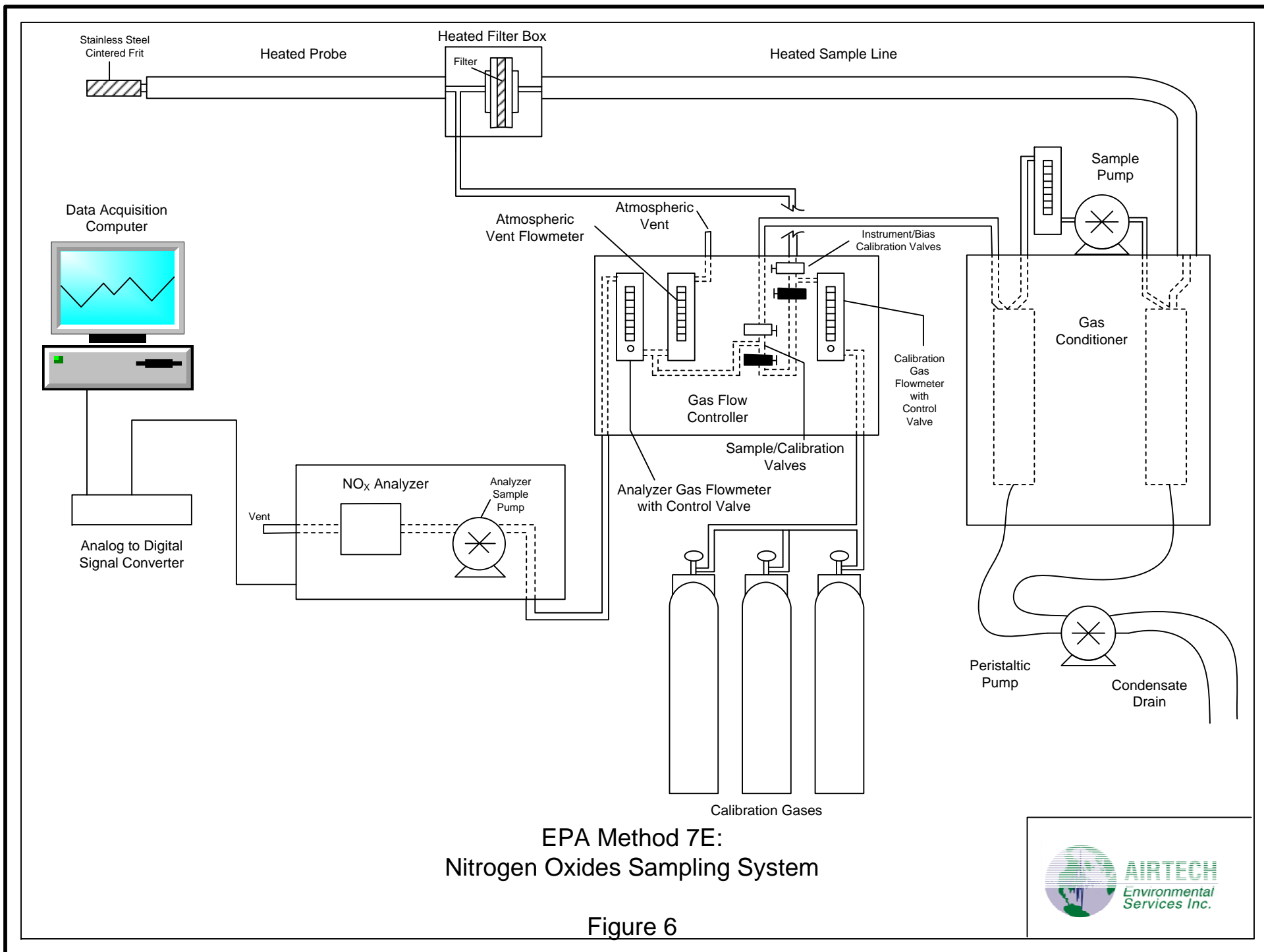


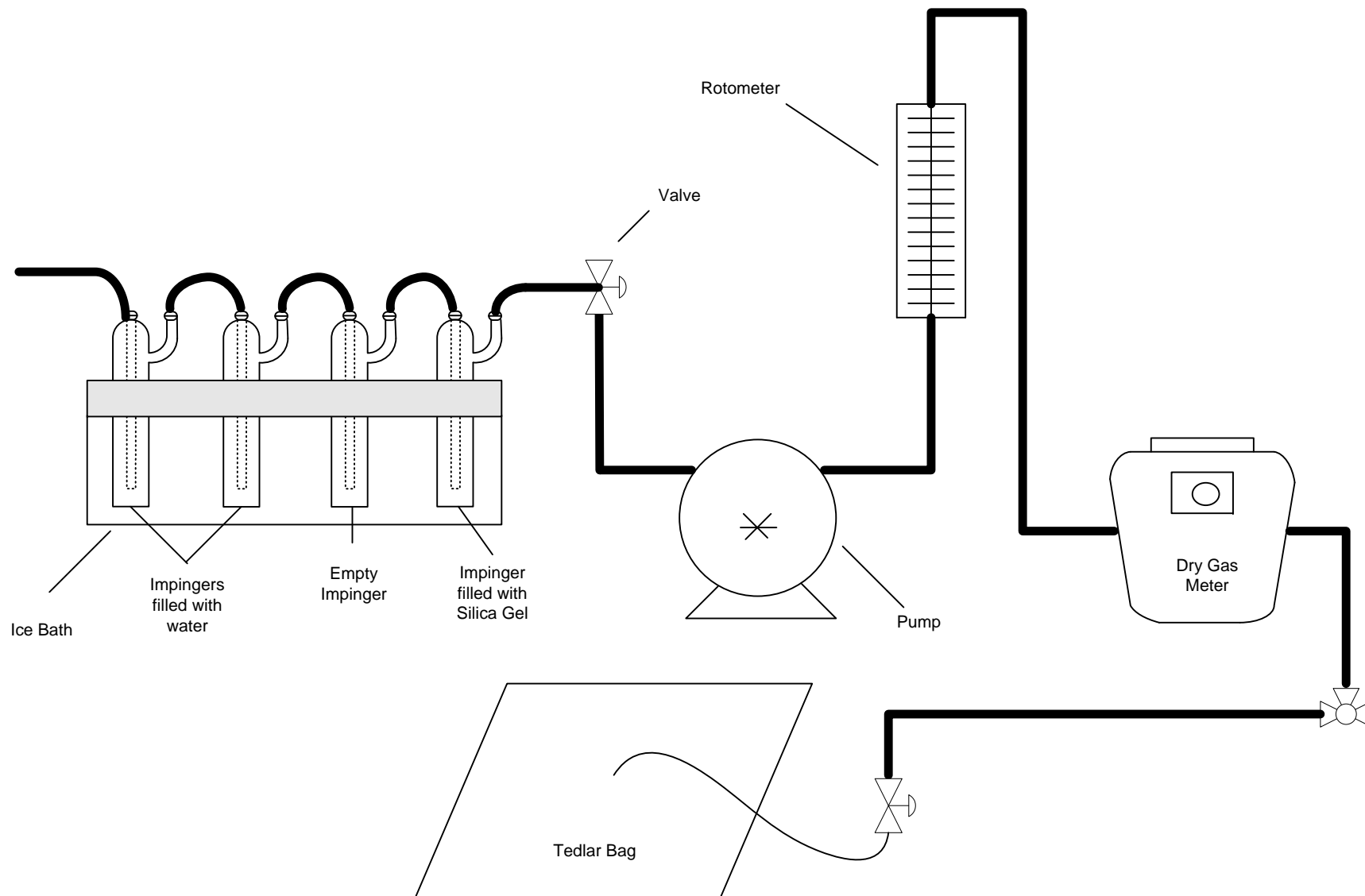
EPA Method 4:  
Moisture Sampling Train  
Figure 4





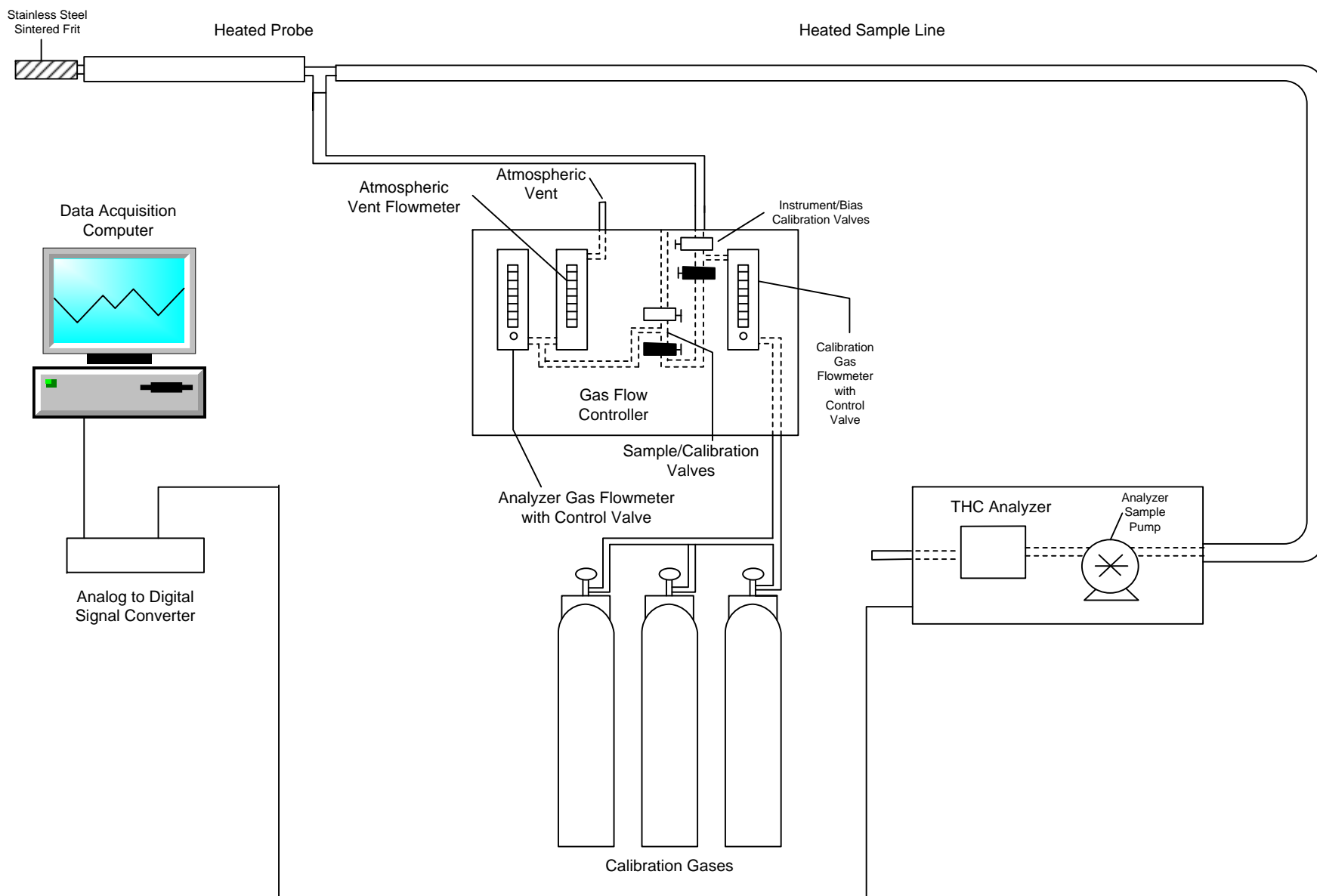
EPA Methods 2, 3, 4, 5 and 202:  
Total Particulate Sampling Train  
Figure 5





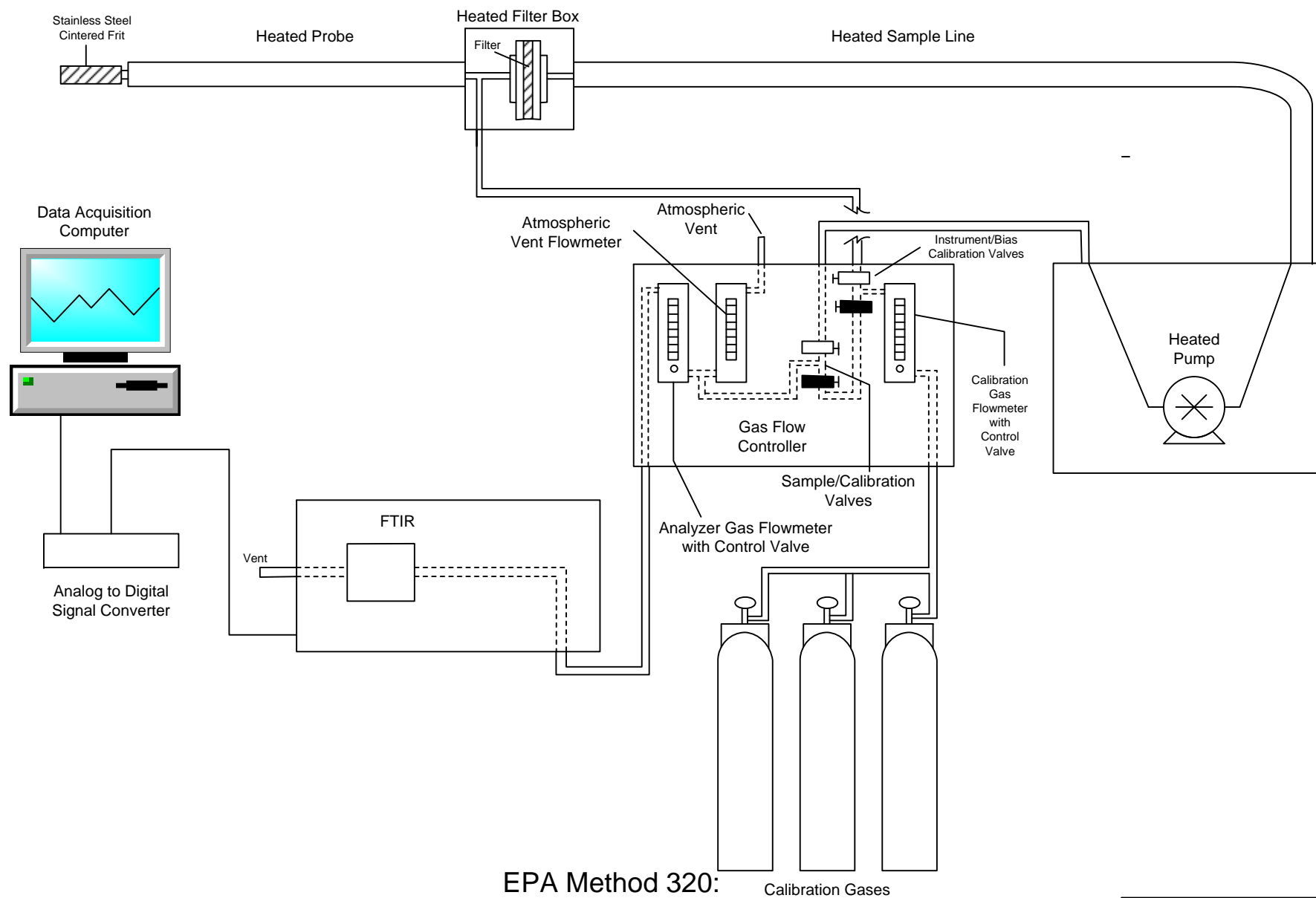
EPA Methods 3 and 18:  
Method 18 Sampling System

Figure 7



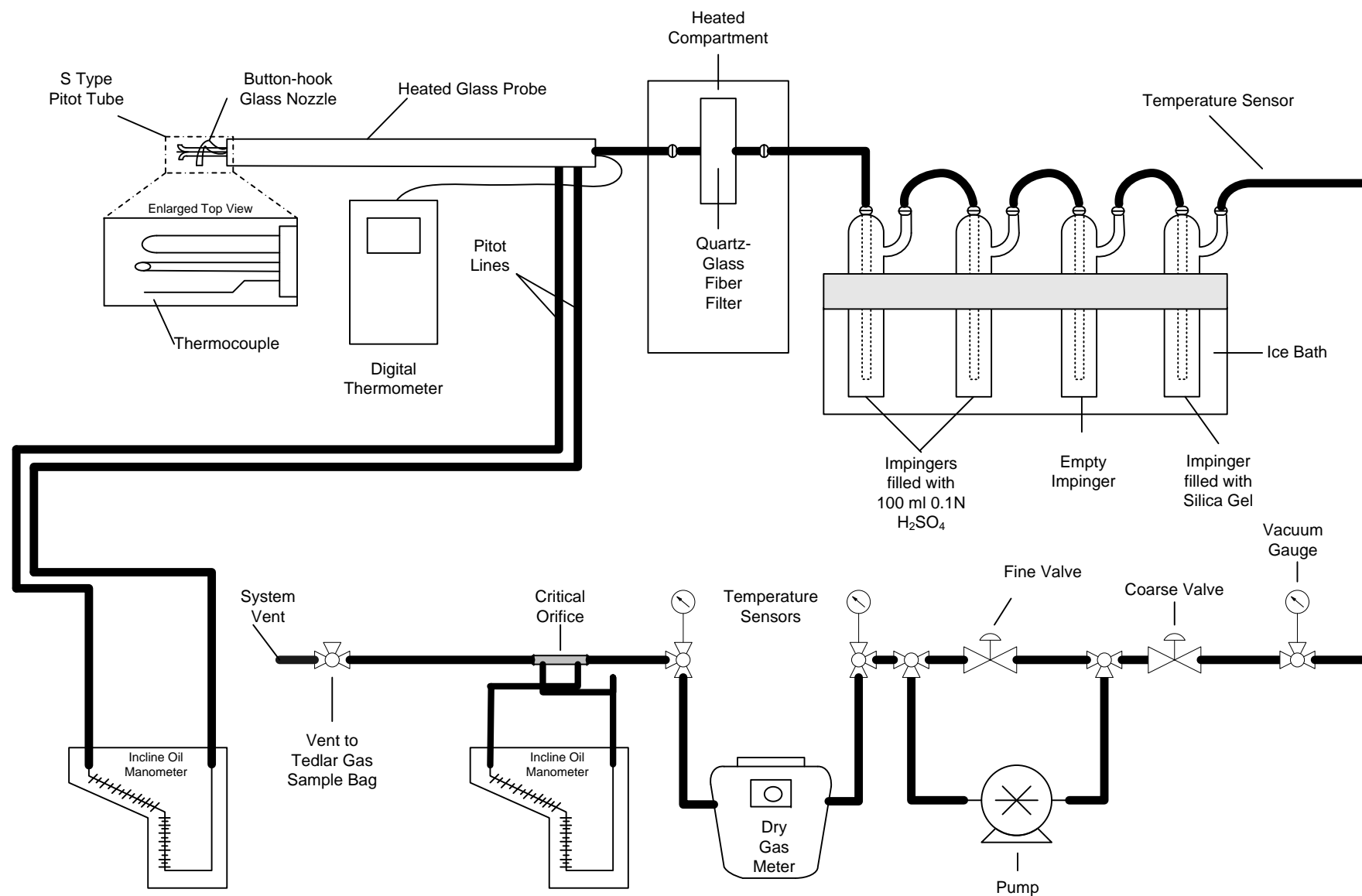
EPA Method 25A:  
Total Hydrocarbon Gas Sampling System

Figure 8



EPA Method 320:  
Vapor Phase Organic and Inorganic FTIR Sampling Train

Figure 9



CTM 027:  
Ammonia Sampling Train  
Figure 10

### *Sample Calculations*

### Area of Sample Location

$$A_s = \pi \times \left( \frac{d_s}{2 \times 12} \right)^2$$

where:

- $A_s$  = area of sample location (ft<sup>2</sup>)
- $d_s$  = diameter of sample location (in)
- 12 = conversion factor (in/ft)
- 2 = conversion factor (diameter to radius)

### Stack Pressure Absolute

$$P_a = P_b + \frac{P_s}{13.6}$$

where:

- $P_a$  = stack pressure absolute (in. Hg)
- $P_b$  = barometric pressure (in. Hg)
- $P_s$  = static pressure (in. H<sub>2</sub>O)
- 13.6 = conversion factor (in. H<sub>2</sub>O/in Hg)

### Volume of Dry Gas Collected Corrected to Standard Temperature and Pressure

$$V_{m(std)} = \frac{17.64(V_m)(Y_d) \left( P_b + \frac{\Delta H}{13.6} \right)}{(T_m + 460)}$$

where:

- $V_{m(std)}$  = volume of gas collected at standard temperature and pressure (scf)
- $V_m$  = volume of gas sampled at meter conditions (ft<sup>3</sup>)
- $Y_d$  = gas meter correction factor (dimensionless)
- $P_b$  = barometric pressure (in. Hg)
- $\Delta H$  = average sample pressure (in. H<sub>2</sub>O)
- $T_m$  = average gas meter temperature (°F)
- 13.6 = conversion factor (in. H<sub>2</sub>O/in Hg)
- 17.64 = ratio of standard temperature over standard pressure (°R/in.Hg)
- 460 = conversion (°F to °R)



## Volume of Water Vapor Collected Corrected to Standard Temperature and Pressure

$$V_{w(std)} = 0.04707 \times V_{wc} + 0.04715 \times V_{wsg}$$

where:

- $V_{w(std)}$  = volume of water vapor at standard conditions (scf)
- $V_{wc}$  = weight of liquid collected (g)
- $V_{wsg}$  = weight gain of silica gel (g)
- 0.04707 = volume occupied by one milliliter of water at standard temperature and pressure (ft<sup>3</sup>/ml)
- 0.04715 = volume occupied by one gram of water at standard temperature and pressure (ft<sup>3</sup>/g)

## Percent Moisture<sup>1</sup>

$$B_{wo} = 100 \times \left[ \frac{V_{w(std)}}{(V_{m(std)} + V_{w(std)})} \right]$$

where:

- $B_{wo}$  = moisture content of the gas stream (%)
- $V_{m(std)}$  = volume of gas collected at standard temperature and pressure (scf)
- $V_{w(std)}$  = volume of water vapor at standard conditions (scf)
- 100 = conversion factor

## Molecular Weight of Dry Gas Stream<sup>2</sup>

$$M_d = \left( 44 \times \frac{\%CO_2}{100} \right) + \left( 32 \times \frac{\%O_2}{100} \right) + \left( 28 \times \frac{(\%CO + \%N_2)}{100} \right)$$

where:

- $M_d$  = molecular weight of the dry gas stream (lb/lb-mole)
- $\%CO_2$  = carbon dioxide content of the dry gas stream (%)
- 44 = molecular weight of carbon dioxide (lb/lb-mole)
- $\%O_2$  = oxygen content of the dry gas stream (%)
- 32 = molecular weight of oxygen (lb/lb-mole)
- $\%CO$  = carbon monoxide content of the dry gas stream (%)
- $\%N_2$  = nitrogen content of the dry gas stream (%)
- 28 = molecular weight of nitrogen (lb/lb-mole)
- 100 = conversion factor

---

<sup>1</sup> The moisture saturation point is used for all calculations if it is exceeded by the actual moisture content.

<sup>2</sup> The remainder of the gas stream after subtracting carbon dioxide and oxygen is assumed to be nitrogen.

### Molecular Weight of Wet Gas Stream

$$M_s = \left( M_d \times \left( 1 - \frac{B_{wo}}{100} \right) \right) + \left( 18 \times \frac{B_{wo}}{100} \right)$$

where:

$M_s$	= molecular weight of the wet gas stream (lb/lb-mole)
$M_d$	= molecular weight of the dry gas stream (lb/lb-mole)
$B_{wo}$	= moisture content of the gas stream (%)
18	= molecular weight of water (lb/lb-mole)
100	= conversion factor

### Velocity of Gas Stream

$$V_s = 85.49(C_p)(\sqrt{\Delta P}) \sqrt{\frac{(T_s + 460)}{(M_s) \left( P_b + \frac{P_s}{13.6} \right)}}$$

where:

$V_s$	= average velocity of the gas stream (ft/sec)
$C_p$	= pitot tube coefficient (dimensionless)
$\sqrt{\Delta P}$	= average square root of velocity pressures (in. H <sub>2</sub> O) <sup>1/2</sup>
$T_s$	= average stack temperature (°F)
$M_s$	= molecular weight of the wet gas stream (lb/lb-mole)
$P_b$	= barometric pressure (in. Hg)
$P_s$	= static pressure of gas stream (in. H <sub>2</sub> O)
85.49	= pitot tube constant (ft/sec)/[(lb/lbmole)(in. Hg)]/[( <sup>0</sup> R)(in. H <sub>2</sub> O))] <sup>1/2</sup>
460	= conversion (°F to °R)
13.6	= conversion factor (in. H <sub>2</sub> O/in Hg)

### Volumetric Flow of Gas Stream - Actual Conditions

$$Q_a = 60(V_s)(A_s)$$

where:

$Q_a$	= volumetric flow rate of the gas stream at actual conditions (acfm)
$V_s$	= average velocity of the gas stream (ft/sec)
$A_s$	= area of duct or stack (ft <sup>2</sup> )
60	= conversion factor (sec/min)

### Volumetric Flow of Gas Stream - Standard Conditions

$$Q_{std} = \frac{17.64(Q_a) \left( P_b + \frac{P_s}{13.6} \right)}{(T_s + 460)}$$

where:

- $Q_{std}$  = volumetric flow rate of the gas stream at standard conditions (scfm)
- $Q_a$  = volumetric flow rate of the gas stream at actual conditions (acfm)
- $T_s$  = average stack temperature ( $^{\circ}\text{F}$ )
- $P_b$  = barometric pressure (in. Hg)
- $P_s$  = static pressure of gas stream (in.  $\text{H}_2\text{O}$ )
- 13.6 = conversion factor (in.  $\text{H}_2\text{O}$ /in Hg)
- 17.64 = ratio of standard temperature over standard pressure ( $^{\circ}\text{R}$ /in.Hg)
- 460 = conversion ( $^{\circ}\text{F}$  to  $^{\circ}\text{R}$ )

### Volumetric Flow of Gas Stream - Standard Conditions - Dry Basis

$$Q_{dstd} = Q_{std} \left( 1 - \frac{B_{wo}}{100} \right)$$

where:

- $Q_{dstd}$  = volumetric flow rate of the gas stream at standard conditions, on a dry basis (dscfm)
- $Q_{std}$  = volumetric flow rate of the gas stream at standard conditions (scfm)
- $B_{wo}$  = moisture content of the gas stream (%)
- 100 = conversion factor

### Total VOC Concentration (as propane), Corrected for Analyzer Drift

$$C_w = \left( C - \left( \frac{c_{0i} + c_{0f}}{2} \right) \right) \left( \frac{c_a}{\left( \frac{c_{si} + c_{sf}}{2} \right) - \left( \frac{c_{0i} + c_{0f}}{2} \right)} \right)$$

where:

- $C_w$  = total VOC concentration, corrected for analyzer drift (ppmwv)
- $C$  = total VOC concentration (ppmwv)
- $C_{0i}$  = initial zero calibration value (ppmwv)
- $C_{0f}$  = final zero calibration value (ppmwv)
- $C_{si}$  = initial span calibration value (ppmwv)
- $C_{sf}$  = final span calibration value (ppmwv)
- $C_a$  = actual span gas value (ppmwv)

### Total VOC Emission Rate (as propane)

$$E_{lb/hr} = \frac{(C_w)(M_{C_3H_8})(Q_{std})(60)}{385.3 \times 10^6}$$

where:

- $E_{lb/hr}$  = total VOC emission rate (lb/hr)
- $C_w$  = total VOC concentration, corrected for analyzer drift (ppmwv)
- $M_{C_3H_8}$  = molecular weight of propane (lb/lb-mole)
- $Q_{std}$  = volumetric flow rate of the gas stream at standard conditions (scfm)
- 60 = conversion factor (min/hr)
- 385.3 = volume occupied by one pound of gas at standard conditions (dscf/lb-mole)
- $10^6$  = conversion factor (fraction to ppm)

### Destruction Efficiency

$$D = \frac{Ei_{THC} - Eo_{THC}}{Ei_{THC}} \times 100$$

where:

- D = destruction efficiency (%)
- $Ei_{THC}$  = THC emission rate of RTO Inlet (lb/hr)
- $Eo_{THC}$  = THC emission rate of RTO Outlet (lb/hr)
- 100 = conversion factor

### Area of Nozzle

$$A_n = \pi \times \left( \frac{d_n}{2 \times 12} \right)^2$$

where:

- $A_n$  = area of nozzle (ft<sup>2</sup>)
- $d_n$  = diameter of nozzle (in)
- 12 = conversion factor (in/ft)
- 2 = conversion factor (diameter to radius)

### Percent Isokinetic

$$I = \frac{0.0945(T_s + 460)(V_{m(std)})}{\left(P_b + \frac{P_s}{13.6}\right)(v_s)(A_n)(\Theta)\left(1 - \frac{B_{ws}}{100}\right)}$$

where:

I	= percent isokinetic (%)
T <sub>s</sub>	= average stack temperature (°F)
V <sub>m(std)</sub>	= volume of gas collected at standard temperature and pressure (scf)
P <sub>b</sub>	= barometric pressure (in. Hg)
P <sub>s</sub>	= static pressure of gas stream (in. H <sub>2</sub> O)
V <sub>s</sub>	= average velocity of the gas stream (ft/sec)
A <sub>n</sub>	= cross sectional area of nozzle (ft <sup>2</sup> )
Θ	= sample time (min)
B <sub>ws</sub>	= moisture content of the gas stream (%)
0.0945	= conversion (°F to °R)
13.6	= conversion factor (in. H <sub>2</sub> O/in Hg)
100	= conversion factor

### Acetone Wash Blank

$$W_a = \frac{(m_{ab})(v_{aw})}{V_{awb}}$$

where:

W <sub>a</sub>	= particulate mass in acetone wash blank (g)
m <sub>ab</sub>	= mass collected, acetone wash blank (g)
v <sub>aw</sub>	= volume of wash (ml)
V <sub>awb</sub>	= volume of acetone wash blank (ml)

### Total Particulate Catch

$$M_n = m_f + (m_a - W_a)$$

where:

- $M_n$  = total particulate catch (g)
- $m_f$  = particulate on filter (g)
- $m_a$  = particulate in wash (g)
- $W_a$  = particulate mass in acetone wash blank (g)

### Particulate Concentration, grains/dscf

$$C = \frac{(M_n)(15.43)}{V_{m, \text{std}}}$$

where:

- $C$  = particulate concentration (grains/dscf)
- $M_n$  = total particulate catch (g)
- $V_{m(\text{std})}$  = volume of gas collected at standard temperature and pressure (dscf)
- 15.43 = conversion factor (grains/gram)

### Particulate Emission Rate (lb/hr)

$$E_{\text{lb/hr}} = \frac{(M_n)(Q_{\text{dstd}})(60)}{(V_{m, \text{std}})(453.6)}$$

where:

- $E_{\text{lb/hr}}$  = particulate emission rate (lb/hr)
- $M_n$  = total particulate catch (g)
- $V_{m(\text{std})}$  = volume of gas collected at standard temperature and pressure (scf)
- $Q_{\text{dstd}}$  = volumetric flow rate of the gas stream at standard conditions, on a dry basis (dscfm)
- 60 = conversion factor (min/hr)
- 453.6 = conversion factor (g/lb)

***Sample Calibration Sheets***

# Airtech Environmental Services, Inc.

## S-Type Pitot Tube Inspection Form

Date \_\_\_\_\_  
Pitot ID \_\_\_\_\_  
Operator \_\_\_\_\_

	Measured	Allowed
Outside Tube Diameter - Dt (inches)		NA
Base To Opening Distance - Pa (inches)		NA
Base To Opening Distance - Pb (inches)		NA
Pa/Dt		1.05-1.50
Pb/Dt		1.05-1.50
Angle, $\alpha 1(^{\circ})$		10
Angle, $\alpha 2(^{\circ})$		10
Angle, B1( $^{\circ}$ )		5
Angle, B1( $^{\circ}$ )		5
Opening to Opening Distance Pa+Pb (inches)		NA
Angle, Z ( $^{\circ}$ )		NA
z (inches)		0.125
Angle, W ( $^{\circ}$ )		NA
w (inches)		0.031

Note Any Damage, Nicks or Dents to the Pitot Tube

Is the Pitot Tube Part of an Assembly

If Yes, Complete the Section Below

Pitot	Measured	Minimum
Distance From Nozzle, X (inches)		0.75 in.
Pitot to Thermocouple Distance, W (inches)		.75"-1"
Pitot to Sample Probe Distance, Y (inches)		3 in.

Does the Pitot Tube Meet the Above Requirements?

Is the Pitot Tube Free of Damage?

If Yes to Both, a Pitot Tube Coefficient of 0.84 is Assigned

If No to Either, then the Pitot Tube Must be Calibrated



## Meter Box Full Test Calibration

Operator:

[illegible]

Nomenclature	
$K'$	Critical Orifice Coefficient
$T_{amb}$	Ambient Temperature ( $^{\circ}F$ )
$V_{cr}$	Volume Through Orifice (scf)
$V_d$	Gas Meter Volume ( $ft^3$ )
$\Delta H$	Orifice Pressure Differential (in. $H_2O$ )
$T_i$	Meter Inlet Temperature ( $^{\circ}F$ )
$T_o$	Meter Outlet Temperature ( $^{\circ}F$ )
$T_{avg}$	Average Meter Box Temperature ( $^{\circ}F$ )
$V_{mstd}$	Volume Metered Standardized (scf)
$Q$	Flow Rate (scfm)
$Y_d$	Meter Correction Factor (dimensionless)
$\Delta H@$	$\Delta H$ yielding 0.75 scfm

Vacuum Guage (in. Hg.)		Thermometers (°F)				Equations
Standard	Vacuum Gauge	Standard	Ch. No.	Ch. No.	Ch. No.	
5		32				$V_{cr} = \frac{K^* \cdot P_b \cdot \theta}{(T_{amb} + 460)^{0.5}}$
10		50				
15		100				$V_{mstd} = \frac{17.64 \cdot V_d \cdot (P_b + (\Delta H/13.6))}{(T_{avg} + 460)}$
20		150				
25		212				$Q = V_{cr} / \theta$
		250				
		300				$Y_d = V_{cr} / V_{mstd}$
		350				
		400				$\Delta H@ = \frac{.0319 \cdot \Delta H \cdot (T_{avg} + 460) \cdot \theta^2}{P_b \cdot Y_d^2 \cdot V_m^2}$
		500				
		600				

## Post Test Meter Calibration

Average Field Sample Rate (Dh)		Date	
Highest Field Vacuum (inches Hg)		Client	
Critical Orifice ID		Project No.	
Orifice Flow Rate (cfm)		Meter ID	

	Run 1	Run 2	Run 3	
Initial Volume (ft <sup>3</sup> )				
Final Volume (ft <sup>3</sup> )				
Volume Metered (ft <sup>3</sup> )				
DGM Inlet Temperature (°F)				
DGM Outlet Temperature (°F)				
Average DGM Temperature (°F)				
Ambient Temperature (°F)				
Elapsed Time (min.)				
ΔH (inches H <sub>2</sub> O)				
Barometric Pressure (inches Hg)				
Pump Vacuum (inches Hg)				
K'				
Vcr (ft <sup>3</sup> )				
Vmstd (ft <sup>3</sup> )				
Post Test Yc				
Full Test Yd				
% Difference				
	Average Difference			


## ***Sample Data Sheets***

# Airtech Environmental Services, Inc.

## Method 1 Data Sheet

LOCATION \_\_\_\_\_

Client	
Project No:	
Plant	
Date	
Technician	
Duct Diameter (in.)	
Port Diameter (in.)	
Port Length (in.)	
Port Type	
Distance A (ft)	
Distance B (ft)	
Distance A (Duct Diameters)	
Distance B (Duct Diameters)	



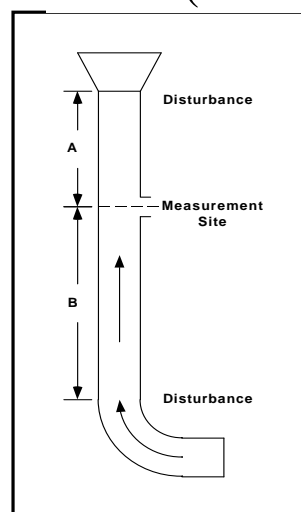
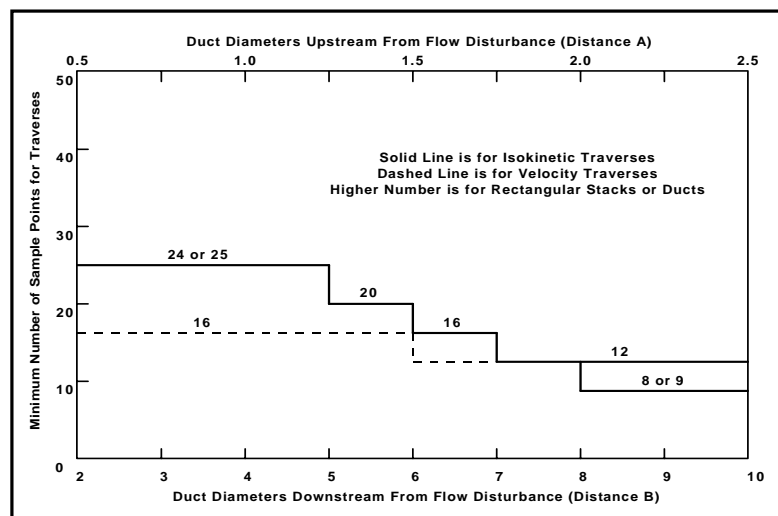
[N] [Up]

First point all the way [in] [out]

Gas flow [in] [out] of page

**Cross Section of Duct**

For rectangular ducts  $ED = \frac{2LW}{(L + W)}$



Location Schematic and Notes	Traverse Point	Distance (in.)
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	11	
	12	
	13	
	14	
	15	
	16	

Indicate sample ports, height from grade, types of disturbances, access, unistrut configuration, etc.  
Distance to point must include length of port



# AIRTECH ENVIRONMENTAL SERVICES INC.

## Oxygen and Carbon Dioxide Data Sheet

PROJECT NO. \_\_\_\_\_

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Client			
Plant			
Location		Date	
Analyzer Type		Leak Check	

$$F_o = \frac{(20.9 - O_2\%)}{CO_2\%}$$

Run No.	Trial No.	%CO <sub>2</sub>	%CO <sub>2</sub> +%O <sub>2</sub>	%O <sub>2</sub>	F <sub>o</sub>	Analyst	Date	Time
Ambient Air	Check							
Run No.	Trial No.	%CO <sub>2</sub>	%CO <sub>2</sub> +%O <sub>2</sub>	%O <sub>2</sub>	F <sub>o</sub>	Analyst	Date	Time
	1							
	2							
	3							
	Average							
	1							
	2							
	3							
	Average							
	1							
	2							
	3							
	Average							
	1							
	2							
	3							
	Average							
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	3							
	Average							
	1							
	2							
	3							
	Average							
	1							
	2							
	3							
	Average							
	1							
	2							
	3							
	Average							

**Notes:**

Run an ambient air check to verify Oxsorb.

Measurements must be made to the nearest 0.2%.

Three different trials should be performed for each sample.

The differences between the trials must not be greater than 0.2% overall.

**Expected F<sub>o</sub> Ranges**

Anthracite/Lignite	1.015-1.130	Nat. Gas	1.600-1.836
Bituminous	1.083-1.230	Wood Bark	1.000-1.120
Distillate Oil	1.260-1.413	Municipal	
Residual Oil	1.210-1.370	Garbage	1.043-1.177

**Airtech Environmental Services, Inc**  
CEM ANALYZER I.D. Data Sheet

Project No. \_\_\_\_\_

Page		of	
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Client			
Plant			
Location			
Date		Unit	
Operator/Tech			

[illegible]

Equipment	Type/Lengths	Used Yes
Probe		
Filter		
HSL		
Cold Lines		
Gas Conditioner		
DAS Computer		
Flow Panel		

[illegible]

CEM Schematic and Notes	

# AIRTECH ENVIRONMENTAL SERVICES INC.

## General Testing Data Sheet

TESTING TYPE: \_\_\_\_\_

RUN NO. \_\_\_\_\_

METHOD NO. \_\_\_\_\_

Page		of	
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Client				Barometric (inHg)		Water [ml] [g]	
Plant				Ambient Temp (°F)		Silica gel (g)	
Location				Static (inH <sub>2</sub> O)		Total Vlc	
Date	Project No.			Probe ID		Liner Type	
Meter Operator				Nozzle ID		Nozzle Dia (in)	
Probe Operator				Filter ID			
Meter ID	Yd			Pitot Cp	Train ID		Train Type
ΔH@	Kf			Leak check	Duct Dim. (in)		Port Length (in)
Pre Leak Check				[cfm] [lpm] @	(inHg)		
Post Leak Check				[cfm] [lpm] @	(inHg)		
Cross Section of Duct				Start Time		Stop Time	

Traverse Point	Min/Point	Velocity	Orifice	Gas Sample	Stack Temp (°F)	Probe Temp (°F)	Filter Temp (°F)	Impinger Outlet Temp (°F)	DGM Inlet Temp (°F)	DGM Outlet Temp (°F)	Pump Vacuum (inHg)	Auxiliary Temp (°F)	Notes
	Elapsed Time	Pressure ΔP (inH <sub>2</sub> O)	Setting ΔH (inH <sub>2</sub> O)	Volume Initial [f <sup>3</sup> ] [l]									
Total													
Average													

Circle correct bracketed [ ] units  
 Train Type denotes impingers, knockouts, etc.



